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ABSTRACT

This research investigated the impact of course placement decisions based on ACT scores or high school subject area grade averages (SGA) on ethnic and gender groups. Course success was predicted from ACT scores or SGA for four standard college freshman courses from 13 to 50 institutions. Mean between-subgroup differences in estimated probability of success and three course placement validity indices were evaluated by gender or ethnic group within course type and institution. All statistics were summarized across institutions by course type and ethnic or gender group. The results of this study showed that, from a statistical perspective, both ACT scores and SGA slightly overpredict course success for blacks and males relative to whites and females. From a practical perspective, the differences between ethnic and gender groups were small. (Contains seven references and five tables.) (Author)

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Differential Prediction/Impact in Course Placement for Ethnic and Gender Groups

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Abstract

This research investigated the impact of course placement decisions based on ACT scores or high school subject area grade averages (SGA) on ethnic and gender groups. Course success was predicted from ACT scores or SGA for four standard college freshman courses from 13 to 50 institutions. Mean between-subgroup differences in estimated probability of success and three course placement validity indices were evaluated by gender or ethnic group within course type and institution. All statistics were summarized across institutions by course type and ethnic or gender group.

The results of this study showed that, from a statistical perspective, both ACT scores and SGA slightly overpredict course success for blacks and males relative to whites and females. From a practical perspective, the differences between ethnic and gender groups were small.

Differential Prediction/Impact in Course Placement for Ethnic and Gender Groups

Research on differential prediction based on standardized test scores and high school grades (e.g., Sawyer, 1985; Young, 1994) has shown slight but statistically significant overprediction of the college GPAs of African-Americans and males, relative to Caucasian-Americans and females. These differences have been described as practically insignificant, however (Linn, 1984; Sanbur & Millman, 1987). A limitations of these studies is that the criterion variables are either pooled subject area course grades (e.g., course grades from all English courses) or first-year GPA. Though generally more reliable than grades in specific courses, pooled grades or GPAs are less interpretable as measures of academic success in the first year in college. A second limitation is that the research does not consider or control for prior selection in admissions or course placement and resulting restriction of range problems (Linn, 1983). Linn (1984) cautioned that over- or underprediction may be influenced by prior selection and/or predictor or criterion unreliability, and therefore should not necessarily be interpreted as proof of prediction bias.

In course placement, the typical decision is whether a student should be placed in a standard-level course, or into a lower-level course (e.g., standard freshman English vs. developmental English or intermediate algebra vs. elementary algebra). For this use of placement variables (e.g., test scores or high school grades), traditional statistics, such as R^2 or χ^2 values, standard errors of estimate (SEE), or differences in regression slopes, appear less informative. A more meaningful approach is to determine how differential prediction affects the outcomes of placement or admissions decisions for specific subgroups. Sawyer (1993) developed an approach to placement validation that focusses on estimating the percentage of correct placement decisions

made about an unselected group of students (students for whom a placement decision is to be made, referred to here as the "placement group"). The estimates are based on logistic regression models developed for students who completed a given course.

This research investigated the differential impact of course placement decisions on male, female, African-American, and Caucasian-American students. Using Sawyer's approach would show, in practical terms, the implications of course placement decisions for these population subgroups, and would eliminate or reduce the restriction of range problems identified by Linn (1984). Differential prediction based on logistic regression was also compared with that obtained using traditional linear regression methods.

Though research has shown that using test scores in combination with either high school grades, subject area grade averages (SGA), or high school GPA results in differential prediction, it has not compared the differential impact of using SGA in course placement with that of test scores. Therefore, test scores and SGA were used separately as predictor variables; the differential impact of course placement decisions based on SGA or on test scores was then compared.

Data

The data for this study consisted of students' grades from over 80 institutions for 11 different college courses, ACT Assessment scores (in English and Mathematics), self-reported high school English and mathematics grade averages, and gender and ethnicity information. The ACT Assessment consists of four academic tests (in English, Mathematics, Reading, and Science Reasoning) and a Composite score, a Student Profile Section, an Interest Inventory, and the Course Grade Information Section (CGIS). Test scores are reported on a scale of 1 to 36. The

CGIS collects information about students' grades in 30 specific high school courses. Self-reported grades collected by the CGIS have been found to be accurate, relative to information provided on students' transcripts (Sawyer, Laing, & Houston, 1988).

To help insure statistical stability and consistency of population subgroups across institutions, only data for the courses from each institution that had sample sizes of at least 50 and subgroup sample sizes of at least 25 were used. The sample for each course was also limited to students with the relevant ACT Assessment score (ACT English for English courses, and ACT Mathematics for mathematics courses), high school subject area grade average (English grade average for English courses and mathematics grade average for mathematics courses), and college course grade. These sample size constraints restricted the number of course types and racial/ethnic subgroups that could be examined. For the gender analyses, four courses were investigated: English composition, intermediate algebra, college algebra, and calculus. For the racial/ethnic analyses, English composition was the only course type for which there were sufficient numbers of African-Americans and Caucasian-Americans within each institution.

Some institutions provided grades for more than one course within a given course type. For these institutions, each course was analyzed separately. Summary statistics were based on courses across institutions within a given course type.

Method

Descriptive Statistics

For each course type and institution, the following descriptive statistics were computed: mean course grade, mean ACT subject area score, mean high school subject area grade average, the percentage of students with a B or higher grade in the course, and the percentage of students

with a C or higher grade in the course. Distributions of these statistics were then summarized across institutions within course type using median, minimum, and maximum values.

Logistic Regression

Three logistic regression models were developed for each course, by institution, for predicting course outcomes (B or higher, or C or higher grade):

- A total group prediction model, consisting of a single prediction equation for all gender or ethnic subgroups. The only predictor was the relevant ACT Assessment test score or SGA, thus modeling the typical usage of one cutoff score for all students by an institution.
- A subgroup-specific model, consisting of the total group prediction model to which a dummy variable denoting subgroup membership (e.g., male or female) was added.
- A subgroup-specific model, consisting of the total group prediction model, a dummy variable denoting subgroup membership, and the interaction between subgroup membership and ACT score (or SGA) as a predictor.

These models would illustrate the differential impact on population subgroups of using a single, total group cutoff score for all students, and would estimate subgroup-specific cutoff scores and their impact on student success.

Differential Prediction

For each course type, subgroup-specific probabilities of success (B or higher, or C or higher grade) were calculated using the subgroup-specific ACT score or SGA prediction model. The logistic regression weights from the models were applied to the ACT scores or SGA of all

students at each institution with valid predictor data (i.e., the placement group), resulting in an estimated probability of success for each student. Then, for each course type, a mean between-subgroup difference in probability of success was computed. The difference at each ACT score or SGA was weighted by the number of females (in the gender analysis) or African-Americans (in the ethnic analysis) in the placement group for the course. The median, minimum and maximum mean differences across institutions, within course type, were calculated.

Differential Impact

Differential impact was assessed using hypothetical cutoff scores. For each course type and institution, the optimum total group cutoff score was identified based on the total group prediction model. Optimum cutoff scores correspond to a .50 probability of success; these scores maximize the estimated percentage of correct placement decisions for a given course. Subgroup-specific optimum cutoff scores were estimated from the subgroup-specific prediction equations.

Using the total group and subgroup-specific optimum cutoff scores, the following statistics were estimated for each course type, institution, and gender or ethnic subgroup: 1) the percentage of placement group students that would be placed into a lower-level course, 2) the percentage of successful students among those who would be placed into the course (success rate), and (3) the percentage of correct placement decisions (accuracy rate). Optimum cutoff scores and differential impact statistics were summarized across institutions using median, minimum and maximum values.

Linear Regression

Linear regression analyses were performed to determine if there was differential prediction of course grades for females or males, or for African-Americans or Caucasian-Americans.

Separate regression models were developed for each course using either ACT subject area score or SGA. The typical mean difference between observed and predicted course grade across institutions, based on a total group linear regression model, was used to indicate the presence and direction of differential prediction. Squared multiple correlations (R^2) and standard errors of estimate (SEE) were also developed using subgroup-specific regression analyses. The median values across institutions were used to examine differences between subgroups in the amount of variance explained and accuracy of the predicted course grades.

Results

The differential prediction and differential impact results for the C-or-higher success criterion were essentially the same as those for the B-or-higher success criterion. For some courses, however, very few students received course grades lower than a C; consequently, logistic regression equations for the C-or-higher success criterion could not be developed for these courses. The B-or-higher results are therefore reported here, to maximize the number of institutions and courses that could be studied. The C-or-higher results may be obtained from the authors.

Descriptive Statistics

The distributions of descriptive statistics are summarized, by course type, in Table 1. For each course type, and for each gender or ethnic subgroup, the number of institutions and the number of courses are reported, as well as median, minimum, and maximum mean ACT subject area score, SGA, and course grade. The last column provides the distribution of the percentages of students who received a B or higher grade.

For all courses except English composition, males typically had higher ACT scores and

lower SGAs and college grades than females. A higher percentage of females than males typically had B or higher grades in English composition, but median percentage differences for the other course types did not exceed 5%. Caucasian-American students typically had higher ACT scores, slightly higher SGAs, and higher English composition grades than African-American students. Of Caucasian-American students, 60% typically had B or higher grades, compared to 39% of African-American students.

Table 1
Descriptive Statistics Summarized Across Institutions

Course type	No. of inst./ no. of courses	Subgrp.	Mean ACT subj. area score		Mean HS subj. area grade aver.		Mean course grade		Percentage with B or higher grade	
			Med	Min/max	Med	Min/max	Med	Min/max	Med	Min/max
English comp.	40/47	Females	20.3	14.1/25.7	3.18	2.61/3.56	2.70	2.07/3.54	65	27/95
		Males	19.7	14.1/24.7	2.88	2.29/3.28	2.40	1.70/3.42	51	22/89
Inter. algebra	13/13	Females	19.1	16.0/20.0	2.72	2.13/2.90	2.13	1.39/3.20	39	20/82
		Males	19.5	17.2/21.1	2.53	2.18/2.84	1.94	.88/3.03	35	13/78
College algebra	22/25	Females	20.9	18.2/25.4	3.14	2.46/3.60	2.28	1.05/2.78	46	18/65
		Males	21.7	18.8/25.2	2.97	2.30/3.41	2.08	.83/2.76	41	13/64
Calculus	12/16	Females	26.2	20.2/30.0	3.64	2.89/3.83	2.53	1.96/3.00	52	36/74
		Males	26.7	20.4/30.8	3.50	2.62/3.77	2.43	1.88/3.03	51	27/70
English comp.	8/11	Afr.-Am.	17.3	13.3/20.9	2.86	2.41/3.16	2.25	1.47/3.00	39	11/75
		Cau.-Am.	20.6	14.3/22.9	2.94	2.48/3.26	2.64	2.02/3.34	60	27/93

Logistic Regression

Differential Prediction

The results showed that the total group prediction models based on ACT Assessment score or SGA were statistically significant ($p<.05$) for 92% of the models based on ACT scores and 85% of the models based on SGA. The gender dummy variable added to the total group ACT or SGA prediction models was statistically significant for 42% and 27%, respectively, of the

courses studied; and the ethnic subgroup dummy variable was significant for 23% and 63% of the courses. The interaction terms (ACT score or SGA by gender or ethnicity) were not statistically significant over and above the dummy variable models for nearly of the courses (> 90%). The interaction terms were therefore dropped from all subsequent analyses.

Table 2 contains the median, minimum, and maximum weighted average gender differences in the estimated probability of success by course type. For every course type, females had a slightly higher median probability of success than males, based on ACT scores (.08 to .10). The median differences between gender subgroups based on SGA (.02 to .06) were slightly smaller than those based on ACT scores (.08 to .10). However, the range of gender differences in probability of success across institutions was larger for all course types when based on SGA than on ACT score.

Table 2

Gender Differences in Probability of Success
Using B-or-higher Success Criterion
(Female probability minus male probability)

Course type	Weighted average gender difference in probability of success					
	ACT			SGA		
	Median	Minimum	Maximum	Median	Minimum	Maximum
English composition	.08	-.04	.26	.06	-.08	.27
Intermediate algebra	.10	.02	.18	.05	-.03	.17
College algebra	.08	-.03	.22	.03	-.17	.17
Calculus	.08	-.07	.17	.02	-.20	.16

The results by ethnic subgroup showed that African-Americans had a lower probability of success in English composition than Caucasian-Americans, whether based on ACT English score (median difference = -.11) or SGA (median difference = -.14).

Differential Impact

Gender subgroups. For every course type except English composition, using a total group ACT cutoff score would generally result in a slightly higher percentage (median difference = 4 to 14%) of females than males placed into the lower-level course. For English composition courses, the median percentage placed into lower-level courses, based on an ACT English cutoff score of 17, was 35% for females and 46% for males (see Table 3).

Using a total group SGA cutoff score would generally result in placing more males than females into lower-level English and mathematics courses. The one exception was calculus, where slightly more females than males would be placed into lower-level courses.

As shown in Table 3, among students placed into a course using a total group ACT cutoff score, the typical percentage of females who would be successful (estimated success rate) was higher (by 8 to 15%) than that for males for all courses. The largest differences were found for English composition (15%) and intermediate algebra (13%). The typical success rates based on a total group SGA cutoff were also higher for females than for males for English composition (10%) and intermediate algebra (8%). Success rates of females in college algebra and calculus were higher than those of males, but the differences were small.

The differences in estimated percentages of males and females correctly placed (accuracy rate) based on total group ACT cutoff scores were relatively small and varied across course types. The differences between medians was no greater than 3 percentage points. The accuracy rate

differences based on SGA were very similar to those based on ACT scores.

Table 3

Differential Impact of Using Total group or Subgroup-specific Cutoffs Across Gender Subgroups (Medians)

Course	Subgroup	ACT score				SGA			
		Opt. cutoff score	Percent placed in lower-level course	Percent successful (success rate)	Percent correctly placed (accuracy rate)	Opt. cutoff score	Percent placed in lower-level course	Percent successful (success rate)	Percent correctly placed (accuracy rate)
Total group cutoff									
English composition	Females	17	35	74	69	2.67	23	72	69
	Males		46	59	66		38	62	67
Intermediate algebra	Females	21	61	74	68	3.34	65	61	66
	Males		50	61	70		68	53	69
College algebra	Females	22	71	68	68	3.26	61	63	66
	Males		61	60	69		65	61	68
Calculus	Females	25	88	65	73	3.49	74	64	69
	Males		78	56	73		72	63	71
Subgroup-specific cutoff									
English composition	Females	16	26	71	69	2.55	18	72	70
	Males	19	55	64	67	2.82	47	64	67
Intermediate algebra	Females	19	50	67	68	3.17	63	60	66
	Males	23	63	67	72	3.54	82	56	69
College algebra	Females	21	58	64	68	3.19	60	62	67
	Males	23	66	64	70	3.36	69	61	68
Calculus	Females	25	79	64	76	3.49	73	64	69
	Males	26	79	62	74	3.39	70	62	71

Compared to the total group optimum cutoff scores, gender-specific optimum cutoff scores across institutions were slightly lower for females and slightly higher for males for every course

type except calculus, as shown in Table 3. Gender-specific cutoff scores were generally 1-2 scale score units lower for females and 1-2 score units higher for males than the corresponding total group cutoff scores. For calculus, the median optimum cutoff score for males was 1 scale score unit higher than the total group cutoff score. Using gender-specific ACT cutoff scores, rather than a total group ACT cutoff score, would generally decrease the percentages of females (by 9 % to 13% and increase the percentages of males (by 5% to 13%) placed in lower-level courses for all course types except calculus. Conversely, it would decrease the typical success rates for females (by 1% to 7%) and slightly increase the success rates for males (by 4 to 6%) for all course types. Accuracy rates for gender-specific ACT cutoff scores were comparable to those obtained using a total group cutoff score for all course types.

Gender-specific optimum SGA cutoffs were generally lower by .2-.3 grade units for females than for males for all course types except calculus. Using gender-specific SGA cutoffs would result in more males (47% vs. 38%) and slightly fewer females (23% vs. 18%) placed into lower-level English courses. Success rates and accuracy rates would typically be comparable to those obtained using a total group SGA cutoff for all course types.

Ethnic subgroups. Using a total group ACT English cutoff score for English composition courses would typically result in a higher percentage of African-Americans than Caucasian-Americans placed into a lower-level course, as shown in Table 4 (63% of African-Americans and 35% of Caucasian-Americans). The estimated percentage of African-Americans who would be successful in English composition courses, given a total group optimum ACT cutoff score, was lower than that for Caucasian-Americans (59% vs. 68%).

Table 4

Differential Impact of Using Total group and Subgroup-specific Cutoffs for English Composition Across Ethnic Subgroups (Medians)

Subgrp.	ACT score				SGA			
	Opt. cutoff score	Percent placed in lower-level course	Percent successful	Percent correctly placed	Opt. cutoff score	Percent placed in lower-level course	Percent successful	Percent correctly placed
Total group cutoff								
Afr.-Am.	18	63	59	62	2.40	52	52	63
Cau.-Am.		35	68	63		29	69	70
Subgroup-specific cutoff								
Afr.-Am.	20	69	62	64	2.79	71	60	65
Cau.-Am.	18	35	68	70	2.21	26	66	70

Using a total group SGA cutoff would also result in a higher percentage of African-Americans than Caucasian-Americans placed into a lower-level course; the median percentage was 52% for African-Americans and 29% for Caucasian-Americans. Compared to using a total group ACT cutoff score, however, using a total group SGA cutoff would result in a lower percentage of successful African-American students than Caucasian-American students. The median SGA success rate was 52% for African-Americans and 69% for Caucasian-Americans.

The typical percentage of correct decisions for African-Americans and Caucasian-Americans, based on a total group ACT English cutoff score (18), was similar for Caucasian-Americans (63%) than for African-Americans (62%). Using a total group SGA cutoff score (2.40), an higher percentage of Caucasian-Americans than African-Americans (70% vs. 63%)

would be correctly placed.

Subgroup-specific optimum ACT English cutoff scores for African-Americans were generally slightly higher than the corresponding total group ACT cutoff scores. Compared to using a total group ACT cutoff score, using subgroup-specific ACT cutoff scores would typically result in higher percentages of African-American students placed into lower-level courses (median = 69% vs. 63%), but higher percentages of African-American students who would be successful (median = 62% vs. 59%), and slightly higher percentages of African-American students who would be correctly placed (median = 64% vs. 62%).

Median subgroup-specific SGA cutoff scores were higher for African-Americans than for Caucasian-Americans, and would results in correspondingly higher percentages of African-American students placed into lower-level courses (median = 71% vs. 52% for African-Americans). Using subgroup-specific SGA cutoffs, rather than total group SGA cutoffs, would typically increase the percentages of correct placement decisions by 2%, and would slightly increase the percentages of African-American students, but not Caucasian-American students, who would be successful (60% vs. 52%).

Linear Regression

The linear regression results were based on only those students who completed each course and who had valid predictor data. Therefore, the limitations of range restriction apply to these results.

Gender Subgroups

The results for gender showed that ACT scores, based on a total group regression model, slightly underpredicted the course grades of females relative to males for all course types, as

shown in Table 5. The largest difference was in college algebra (.29 grade units) and the smallest difference was in English composition (.18 grade units).

Table 5

Linear Regression Results by Gender and Ethnic Subgroup

Course type	Subgrp.	ACT						SGA					
		Observed - predicted*		R^2		SEE		Observed - predicted*		R^2		SEE	
		Med	Min/ Max	Med	Min/ Max	Med	Min/ Max	Med	Min/ Max	Med	Min/ Max	Med	Min/ Max
English comp.	Females	.09	-.07/.36	.09	.01/.35	.84	.50/1.25	.05	-.09/.38	.09	.01/.46	.83	.43/1.26
	Males	-.11	-.40/.06	.06	.00/.26	.97	.53/1.40	-.06	-.42/.09	.10	.00/.30	.94	.53/1.36
Inter. algebra	Females	.10	.03/.33	.12	.03/.20	1.07	.97/1.37	.05	-.01/.26	.08	.01/.34	1.11	.88/1.43
	Males	-.18	-.43/-.06	.06	.00/.13	1.10	.90/1.40	-.09	-.31/.01	.09	.01/.16	1.13	.87/1.38
College algebra	Females	.13	-.12/.32	.16	.01/.29	1.07	.78/1.34	.05	-.22/.14	.12	.00/.38	1.12	.82/1.34
	Males	-.16	-.29/.18	.10	.03/.44	1.09	.81/1.31	-.05	-.18/.32	.11	.03/.42	1.11	.79/1.28
Calculus	Females	.15	-.12/.30	.19	.05/.42	.99	.76/1.26	.02	-.20/.20	.12	.00/.34	1.00	.76/1.40
	Males	-.09	-.27/.09	.13	.02/.23	1.03	.77/1.25	-.02	-.17/.15	.12	.02/.31	1.02	.81/1.33
English comp.	Afr.-Am.	-.14	-.27/.10	.07	.03/.28	.96	.62/1.21	-.19	-.38/.24	.07	.00/.18	.97	.57/1.22
	Cau.-Am.	.01	-.01/.04	.06	.00/.20	.88	.57/1.17	.02	-.02/.08	.09	.00/.21	.87	.56/1.16

*Based on a total group regression model; R^2 and SEE values are based on subgroup-specific models.

SGA also slightly underpredicted the course grades of females relative to males for all course types (differences of .11, .14, .11, and .04 grade units), based on total group SGA regression models. Gender differences using SGA were smaller than the differences found with ACT scores. (Note: Adding high school grades to ACT scores in a two-predictor regression model slightly reduced the underprediction of female grades for all course types (by .09 to .11 grade units)).

The relationships between ACT scores, high school grade averages, and college grades differed for females and males; R^2 values based on ACT score for females were .03 to .06 units higher than those for males. ACT scores accounted for the same or more of the variance in course grades for

females than did SGA for all course types (e.g., 19% using ACT Mathematics score vs. 12% using SGA for females in calculus). R^2 values for males were similar for ACT score and SGA models. In general, there was very little difference in prediction accuracy (SEE) for females and males for all course types.

R^2 values also varied across institutions, ranging from .00 to .44 for ACT score and .00 to .46 for SGA. R^2 values based on SGA appeared slightly more variable across institutions than models based on ACT score. Variability in SEE across institutions was similar for ACT score and SGA models.

Ethnic Subgroups

The results for ethnic subgroups, also shown in Table 5, revealed that ACT scores overpredicted English composition grades of African-Americans relative to Caucasian-Americans by .15 grade units (-.14 vs .01) SGA also overpredicted the English composition course grades of African-Americans, relative to Caucasian-Americans, by .21 grade units (-.19 vs. .02). (Note: adding ACT scores to SGA in a two-predictor regression model slightly reduced the overprediction of English composition grades for African-Americans (to -.10)).

The differences between African-Americans and Caucasian-Americans in prediction accuracy for English composition (as measured by R^2) were small for all three regression models (R^2 of .07 vs .09) However, using ACT scores and SGA jointly reduced SEE slightly for African-Americans (by about .09 grade units).

Discussion

The results of this study were consistent with prior research (e.g., Sawyer) showing that both ACT Assessment scores and high school subject area grade average slightly overpredict college English composition and mathematics course grades of males relative to those of females, and English composition grades of African-Americans relative to those of Caucasian-Americans. Differential

prediction based on both logistic and linear regression was slight for both ethnic and gender subgroups, corresponding to the difference between a B and a B- grade. This would seem to indicate that factors other than cognitive achievement (e.g., social support. family values concerning education, aspirations) contribute to differential performance. Further research on these factors would help in determining these relationships.

Both ACT Assessment scores and high school grade averages differentially predict college performance of ethnic and gender subgroups to some degree but, from a practical impact perspective, the differences between ethnic and gender subgroups are very small. Placement accuracy, and R^2 and SEE values were fairly consistent across ethnic and gender subgroups. Further, were institutions to move towards subgroup-specific cutoffs, or towards adjusting their placement requirements to balance subgroup representation on the basis of, for example, the percentages of students placed in the lower-level course, there would likely be consequences in terms of placement accuracy and the percentages of students placed into the course who would be successful.

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